A·L·E·R·T

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alberta environmental research trust

A NEW APPROACH TO ENVIRONMENTAL RESEARCH

The Alberta Environmental Research Trust (AERT) is pleased to introduce this inaugural edition of a novel Newsletter. The objective is to inform Alberta industry and the research community on how AERT can assist in the development of new technologies to protect and enhance the environment.

Many of our environmental concerns and controversies arise from a lack of reliable technical information on the precise nature of industrial effluents and their environmental impacts. The AERT is now in a position to offer co-funding assistance to support scientific research into the cause and effects of these phenomena.

The AERT is a unique organization, created as an Alberta corporation in 1971, to facilitate the expansion of research and development for the preservation and improvement of the environment. Although some of its' funds are provided by Alberta Environment, the AERT is operated by an independent Board of Trustees. Additional funding has recently been committed from the Lottery Fund, thereby making it possible for the AERT to participate in larger environmental research projects.

In addition to funding assistance the AERT can provide access to the Alberta Environmental Centre for its research partners and grantees. This state-of-the-art facility in Vegreville is staffed by recognized experts in environmental sciences, and is equipped with extensive laboratory and pilot plant apparatus.

The AERT is registered as a charitable organization with the authority to issue tax receipts for private funds provided to AERT for co-funding environmental research projects.

The procedure for developing a joint research project is quite simple. Members of the AERT are available to discuss any major project concepts and the prospects for co-funding. The Applicant submits a proposal to the AERT office in Calgary on a relatively simple application form. The Grants Advisory Committee evaluates the technical merit of the proposal, and a final decision is rendered by the AERT Board of Trustees. The research can be done in-house by the co-funding partner or contracted either to a research agency or to a consulting firm.

Harold V. Page, P.Eng.
Chairman

MINISTER'S MESSAGE

As Minister responsible for the Alberta Environmental Research Trust (AERT), I am pleased to have the opportunity to welcome you to this, the first issue of the Trust's newsletter.

Since its inception on April 16, 1971, AERT has consistently filled its mandate, to liaise with industry in the interests of financing environmental research projects.

We realize that as technology enables Albertans to lead an unmatched quality of life, we also must live within the boundaries set by our environment. Intricate research ensures Albertans successfully combine the two — before, and not after the fact. Without such research, we would not be able to protect, improve and wisely use our environment, clearly a strong priority of our Government.

Because of the absolute necessity of environmental research programs and the tremendous amount of attention directed to this field, I am confident that both our environment and our quality of life will continue to improve.

I applaud AERT's past involvement in protecting our environment and wish all readers of this newsletter every success with current and future research. We will all be the beneficiaries.

Sincerely yours,

Ralph P. Klein
Minister

VIABLE SEWAGE TREATMENT PLANTS FOR SMALL COMMUNITIES

There is growing concern in our time over the problem of pollution of our environment and in particular, that of safeguarding our rivers and lakes from whence we derive, for the most part, our drinking water supply. No longer can we allow the discharge of our waste matter, including sewage, into these important lifelines.

It has been estimated that in a typical metropolitan area, domestic sewage resulting from the day to day activities of people such as bathing, body elimination, housekeeping, cooking and recreation averages some 60 gallons per capita per day. Thus, for a city the size of Edmonton, approximately 36 million gallons of domestic sewage has to be disposed of per day! This is a remarkable figure when you consider that it does not include industrial waste.

However, for a city the size of Edmonton, sewage treatment plants can be built and operated fairly economically and modern technology has produced such plants that have highly efficient primary, secondary and tertiary treatments enabling the resultant effluent to be passed into the rivers without causing any ill-effects.

But what about the smaller communities and recreation areas such as campgrounds, ski resorts, and certain smaller industrial concerns? They cannot afford the capital outlay for major treatment plants as can the big cities. Nor can they just dump their raw sewage into adjacent rivers or lakes for obvious environmental and health reasons.

Recognising this important need, David Bromley Engineering (1983) Ltd. of Edmonton embarked on a research project to investigate and develop a reliable, effective and simple to operate sewage treatment system that could be utilised by any of the small users we have mentioned.

The funding of this research project was underwritten by the Alberta Environmental Research Trust to the level of $40,000 over a two year period. The project, in three phases, was organised around the following objectives:

- process reliability
- ease of operation and simplicity of maintenance
- ability to treat fluctuating and intermitten waste loads
- insensitivity to toxic influents
- rapid start-up time

With these objectives in mind, a Biological Activated Carbon Reactor (BACR) system, similar to that found in some major tertiary treatment systems, was selected for the research programme.

Phase 1 was a laboratory scale programme to develop preliminary information regarding the viability of BACR systems. Mechanisms of adsorption and bioregeneration were investigated. (*Note: Adsorption, not to be confused with absorption, refers to the adhering of gases to the interior surface of porous solids, ie as activated carbon adsorbs certain gases. Adsorption is a surface phenomenon; absorption is an intermingling of two substances. Ed.*)

This research resulted in the development of a process that effectively eliminated hydrogen sulphide production in BACR systems. Based on the data obtained in Phase 1, a pilot scale facility was designed and constructed.

Phase 2 was to place the pilot plant in operation at the Devon sewage treatment plant. The objective was to identify process variables, constraints and to optimise the system. Results from this empirical study indicated that the BACR could deliver effluent with a high standard of quality and 99% suspended solid removal. Furthermore, it was determined that the system could be started up in approximately 40 minutes after extended shutdowns.

Phase 3 was designed to further demonstrate the reliability of the BACR under actual plant conditions and to develop information relating to system economy. During this phase the pilot plant performed reliably, efficiently, and demonstrated low sensitivity to variations in flow, sewage strength or toxic influences. Preliminary estimates indicate that the operating costs of the BACR is in the range of 8-12 cents per thousand gallons.

Mr. J. Selann of David Bromley Engineering told *ALERT* that this project is an excellent example of the benefit of Alberta Environmental Research Trust funded research. The funding that David Bromley Engineering received allowed for the identification of specific needs for innovative technology in the field of small sewage treatment plants and the result was the development of a reliable system that will be of benefit to all Albertans.

Insight

Welcome to the first edition of *"ALERT"*. Within these pages you will find articles describing some of the activities of the Alberta Environmental Research Trust. We have tried to present these in an interesting, lively way to appeal to both the lay reader as well as the professional. Our intention is to pass on interesting news and highlights of happenings in the area of Alberta research and development. Obviously for reasons of patents and copyrights, we cannot always give you every detail of some of the processes or findings. However, should you be interested in learning more of which we write, please feel free to contact either the Trust or the person/s involved in the article.

We also welcome your views and suggestions. Please write to

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THE HYBRID POPLAR OF SOUTHERN ALBERTA

As anyone who has driven across the treeless prairie, perhaps en route from Saskatchewan through to B.C., can attest the river valleys of southern Alberta provide a welcome relief from the somewhat plain landscape. These valleys are veritable oases dominated as they are by poplar forests, which are not only refreshing to see but also provide nesting sites for birds, cover for wildlife, and a forest canopy under which an understory of herbs and shrubs thrive.

There is an interesting fact which may be lost on the average citizen as he drives through the Oldman River Basin, that being, that this is the only place in Canada, and probably the world, where three poplar species grow together. The three types are the Balsam poplar which grows rapidly but only lives for about fifty years, the Plains Cottonwood and the willow like Narrowleaf Cottonwood. These trees freely cross-fertile and naturally hybridise producing a trispecific hybrid swarm with a vast range of variety. This cross hybridising has probably been going on for thousands of years.

The possible uses of these trees has not been adequately recognised, partly because this type of tree is considered by most Albertans to be weed trees. However, the characteristics which make them "weeds" are the same properties which may underlie their usefulness. Typical would be their rapid growth, ease of propagation, and broad range of adaption. However, these natural hybrids, because they grow naturally in this part of Alberta, are among the only trees that can be grown to protect and soften farmsteads, provide shelterbelts, and offer means of streambank stabilisation and erosion control.

In the past, artificial poplar hybrids have been propagated and distributed for these uses. These introduced poplars have been found to be susceptible to insects and diseases and have less resistance to the warm, drying winds, particularly during the winter Chinook. Consequently, many of the introduced shelterbelts and farmstead plantings are decrepit or already dead. Interestingly enough, early settlers to southern Alberta often simply transplanted or propagated local trees and some of the resultant groves of native poplars are still thriving.

The hybrid poplars have short fibres and are thus not desirable as construction materials, but are very suitable for low quality pulp such as is used for newsprint, the largest single use of Canadian trees. This has led to the establishment of hybrid poplar plantations to be used for pulp production.

While there has been a major research thrust toward the breeding of artificial poplar hybrids the natural variety has been relatively ignored. The unique trispecific hybrid poplar swarm in southern Alberta offered an ideal opportunity to collect and study native Canadian poplar hybrids. Thus it was that Dr. Stewart Rood, Associate Professor of Biology of the University of Lethbridge, approached the Alberta Environmental Research Trust (AERT) with a fourfold proposal to thoroughly research and assess our natural hybrid poplars.

The objectives of the research were:

- to clarify the complicated and previously contradictory status of poplar species and hybridisation in the Oldman River Basin
- to systematically map the distributions of the three species and hybrids
- to collect representatives of the various poplar hybrids
- to establish these in a nursery plot for further study and ultimately to propagate for local plantings

The AERT agreed to assist Dr. Rood in his research and provided funds for a three year period.

During the project, the four objectives were completed. The status of the species and hybrids was clarified and relatively simple identification keys were established for individual trees. Clones were collected from across southern Alberta and have been successfully established in a nursery plot at the University of Lethbridge. Some of these have demonstrated rapid growth, favourable form and appearance and disease resistance. Five superior clones are to be sent to the prairie tree nursery in Saskatchewan for further testing and possible general release.

**Upper St. Mary — Dr. Stewart Rood*

While the project was proceeding, an unexpected observation emerged. Trees were systematically sampled from all river valley poplar forests in the Oldman River Basin. However, the health of the various forest groves varied dramatically, some were quite healthy, whilst others had died. The recent death was evident by the presence of dead skeletons of trees fallen over as well as an absence of young trees. The pattern of dead forests soon became clear. Forests along the lower St. Mary River were almost completely dead while many decrepit forests existed along the lower Waterton River. In contrast, the Belly River, located between the other two, still supported relatively healthy forests.

The major difference between the Belly River and its neighbours is the absence of large dams. The correlation between river damming and downstream poplar decline seemed possible. To test this, aerial photographs taken before and after the damming of the St. Mary and Waterton Rivers were examined and it was found that many of the forests along these rivers had died after damming. These observations indicate the need for further understanding of the environmental impacts of river damming.

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PHYSICAL TESTING OF GEOMEMBRANES

The use of geomembrane lining systems to control seepage from waste or storage systems is increasing. One of the widely publicised projects of late was the proposed new landfill development at Arum by the City of Edmonton. The design of storage ponds for retaining hazardous wastes of process fluids is also steadily moving away from packed clay or cement stabilised sand linings to geomembranes.

These geomembranes, manufactured as thin sheeting from high density polyethylene, promise a high degree of impermeability with design life typically conceived as stretching twenty years or more. However, a plastic liner is only as good as its' seam welds, stress levels, and if the sheet remains intact over the design life of the pond.

The Edmonton firm of Hanson Materials Engineering, who specialise in all areas of material testing and inspection, have already started to see service failures of geomembranes after only two or three years service life. Some of these premature failures have been catastrophic and expensive, particularly in industrial situations. The potentially large economic impact associated with pond repair and the environmental damage caused by these failures pose a real and increasing threat to industry. This has led many designers and users to believe that estimations of design life may have been overly optimistic.

Consequently, Hanson's embarked on an investigation into the physical test methods for geomembranes with the objective of developing a more complete procedure for analysing the thermal fusion zone in seams. It was discovered, the current geomembrane test methods were in a state of disarray and therefore it was important that current test specifications and methods had to be critically reviewed and suggestions for improvement made where necessary.

A second aspect of this much needed research is that geomembrane seam welding and its associated quality control procedures are only now being developed into reproducible and defined systems. The fact that the geomembrane industry is in its infancy becomes apparent when compared, for instance, to the polyethylene gas distribution piping industry which also had its problems resulting in vast sums of money and man-hours being expended in research.

Geomembrane fusion is often difficult to implement because of a host of variables not easily controlled. For example, the geomembrane surface temperature can be greatly affected by air and ground temperature variations during a single working day. Examples of the resulting irregularities in the quality of the end product are constantly being observed in this industry.

A third aspect that was looked at involved liners that are exposed or partially exposed to the atmosphere. This condition places severe demands on this material in a sheet configuration. Some retaining ponds are only filled to a certain level and the interface between exposed and unexposed areas can be subject to considerable thermal stress. Liners thus exposed are also susceptible to degradation of properties from ultraviolet radiation.

From these remarks, it is quite obvious that effective quality assurance and control procedures must be quickly developed to meet even the short term requirements of the industry. The results of Hanson's research has developed such procedures including the "Z-axis tear test." Simply stated, this is a seam integrity test carried out by notching the geomembrane seam in a certain manner and by using a wedge, tear the seam for inspection. The procedure is sufficiently straight forward that it can be adapted to field testing without a great deal of development in equipment.

The Alberta Environmental Research Trust was pleased to be able to support Hanson's in this valuable research and made available a grant of $25,000 for the studies. It is recognised that much work and research has yet to be done to ensure the safety of our environment from the ravages of toxic wastes and the like. However, the development of the Z-axis tear test for geomembrane seam welds will go a long way in helping establish the safety of storage systems.

THE BEAVER'S REVENGE!

If there is one thing we humans take for granted, it is our drinking water. What is simpler than going to the kitchen sink, turning on the tap and drawing a pot full of cool water when we want to make our coffee or other favorite beverage? But wait a moment — are you sure that drinking water is safe? In these days of chlorination, fluoridation and ozonisation no one likes to think there might be something infectious in their drinking water. However, in spite of all the precautions taken by public authorities and municipalities, occasionally something does get through and problems arise.

A great many living organisms make their home in freshwater and surprisingly enough, disease causing agents from wild animals may reach even the most remote and pristine water sources. One of the most common problems encountered in North America is the spread of giardiasis from wild and domestic animals via water.

Giardiasis, known colloquially as the Beaver's Revenge, is an infection of the digestive system caused by a microscopic parasite called *Giardia lamblia*. It has a simple life cycle; the adult trophozites grow in large numbers on the microscopic villi on the inner surface of the intestine and encapsulate to form a small, elliptical cyst that passes out in the faeces. The cyst can remain viable for up to two months in cold water and the ingestion of only a few can transmit the infection to a new host body.

The cyst is very resistant to chlorine and other chemicals commonly used to disinfect drinking water and its small size makes it difficult to filter out. Many waterborne outbreaks of giardiasis have occurred in recent years at several places in Alberta.

The resultant infection is most uncomfortable for humans, taking the form of extreme diarrhoea coupled with discomfort and distension of the stomach, nausea and often an inability to properly absorb food. The condition can last for several weeks or more and requires medication to kill the parasite.

In 1982, such an outbreak took place in Banff, close to the site of the University of Calgary's Kananaskis Field Station. At the time, nothing was known about the occurrence or extent of giardiasis in either animals or water resources in Alberta. Accordingly, in 1983, a proposal was submitted to the Alberta Environmental Research Trust (AERT) by Dr. Peter Wallis of the U of C entitled *Host Reservoirs of Giardiasis in Alberta*. The AERT on examination of the proposal agreed to fund the research over a three year period and this subsequently laid the groundwork for an entire programme of applied drinking water research at the U of C that eventually achieved international recognition.

Thus, funding from the AERT enabled an Alberta institution to place itself on the leading edge of water research and technology. Some of the most important findings and results of the work funded by the AERT were:

- a filtration technique was developed for cyst detection that was used to monitor waters in Kananaskis Country. This played a fundamental role in later applied drinking water research.
- a survey was carried out to establish prevalence rates of infection in wild and domestic animals in southern Alberta.
- development work on culturing of *Giardia* trophozites and animal models was carried out.
- the human pathogenicity of animal isolates was evaluated using classical and novel techniques.
- the work was published in the scientific literature and presented to scientific, engineering, and public groups at numerous conferences and lectures.

In the mid-1980's *Giardia* research was a rapidly expanding field in many areas of the world. In order to respond to the need for information and scientific interchange, the U of C research team began organising a major international conference which was held in 1986. Once again, the AERT was approached for funding and so became involved in the Calgary *Giardia* Conference along with Alberta Environment, the Alberta Environmental Centre, the U of C, and Health and Welfare Canada. This conference was a great success, being attended by 155 delegates from Canada,

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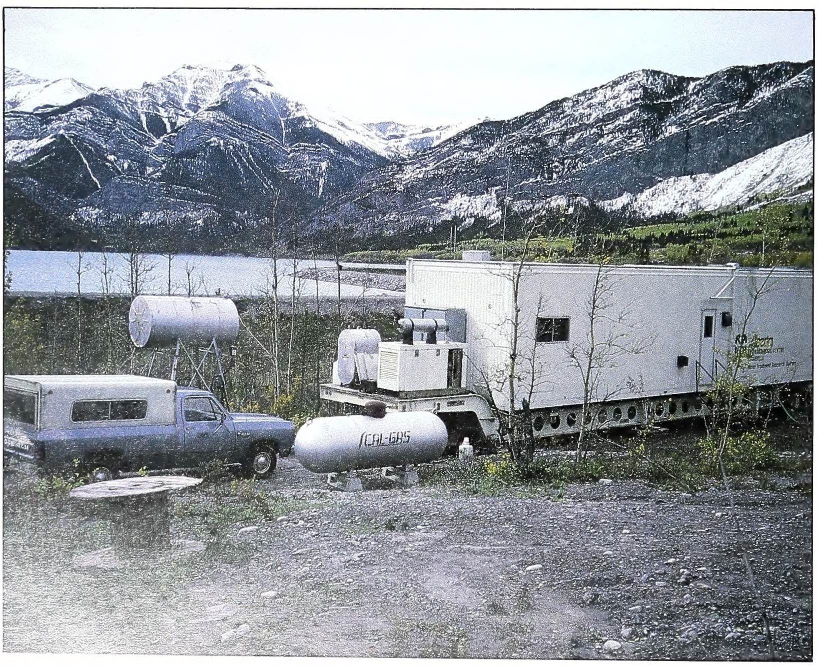
**Water treatment pilot plant, Kananaskis — Peter Wallis*



UNDERGROUND STORAGE TANK LEAK DETECTION

It is very doubtful that the average motorist gives any thought to what is happening below his feet when he pulls into a service station to have his tank filled. Yet, beneath the surface lies a potential hazard. Each service station has at least two, and possibly four, underground tanks in which is stored the gasoline you have pumped into your car.

What happens if these tanks leak? Just because they cannot be seen doesn't mean the possibility of leaks does not exist. There are approximately 350,000 underground gasoline storage tanks in Canada, including those for home heating fuel, and some 3.5 million gasoline storage tanks in the US. The Environmental Protection estimates that 38% of these tanks leak approximately one gallon of gasoline per day.

Put another way, most people were horrified at the tremendous environmental damage caused by the huge Exxon Valdez tanker spill of last year. Millions of barrels of crude were spilled onto the shorelines of Alaska. The leakage rate from underground storage tanks actually represents the equivalent of one Valdez spill *per day*. Where does this fuel go? It leaches through the soil and can eventually find its way into natural aquifers and hence into our drinking water supply. Or, as has been reported many times in the press, can mysteriously find its way into our storm sewers. In essence, this is a serious problem.

However, in 1977 Athabasca Research of Edmonton were approached by a major oil company to investigate ways and means of testing the integrity of underground tanks quickly, efficiently and safely. There were in existence at that time other methods of tank testing but they were time consuming, and by their very nature actually added to the leakage rate. Therefore, a completely new approach was needed and much research would have to be conducted.

In order to get the research underway as quickly as possible, Ed Adams, President of Alberta Research, decided to apply for funding assistance to the Alberta Environmental Research Trust. Recognising the importance of this research and its ultimate benefit to the environment, the Board of Trustees approved an initial grant of $30,950. With this grant, Athabasca Research embarked on a study to investigate the feasibility of developing a leak detection system based on the vacuum principle. Six problem areas were considered.:

- the nature of the ingress of air and water into a leaking tank
- methods of detecting the ingress of air
- methods of detecting ingress of water
- structural stability of tanks
- vapour recovery
- mechanical design considerations.

Several experiments were carried out to supplement the study from which it was concluded that a prototype system should be designed and developed. Once again the AERT were approached for funding assistance and two additional grants, totalling almost $125,000 were approved. As a result, a new system of tank leakage detection was developed, patented, and made available under the name of "Vacutect."

This new system is a fast means of tank testing, taking only two hours or less. Stations need not be shut down during testing, neither do the storage tanks have to be filled with compressed air which would contribute to the loss of fuel in the event of a leak.

Simply put, this new system comprises a stainless steel probe, a vacuum pump and a computer. These components are housed in a specially equipped van. The probe is lowered through the storage tank fill pipe which is then sealed by an inflatable bladder. Signals from the probe are fed to the computer via a multiconductor cable.

A vacuum line is connected to the tank vent pipe and the computer reduces the pressure in the tank sufficiently to cause air and/or water to leak into the tank through any existing leaks. This air forms bubbles over each leak. As each bubble reaches sufficient size to break loose and float to the surface, it undergoes a volume pulsation.

The frequency of these vibrations is inversely proportional to the hole size thus indicating the leak size. The sound of these vibrations, or bubble signatures as they are called, are analysed by the

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The specially equipped "tanknology" van.

BEAVER'S REVENGE *continued . . .*

the United States, England, Scotland, India, Australia, Czechoslovakia, and Mexico.

Through the *Giardia* Project, AERT became involved in an internationally important research initiative by funding an Alberta scientist to begin work in a new area. Dr. Wallis, in appreciation of the role of the AERT in his research states that unlike most granting agencies who lose interest in research projects after the initial objectives have been met, the flexible nature of AERT funding was instrumental in developing a strategically important project from inception to the final stages of information dissemination and private sector involvement.

To date, AERT has spent and committed $133,350 over seven years and has been a major player in the *Giardia* Project throughout the basic, applied, technology transfer, and private industry spinoff stages. Over the years, the *Giardia* Project at the U of C has also been funded by other sources, but only AERT has been involved from start to finish.

To lay to rest the spectre of the return of the Beaver's Revenge, AERT has funded one final project, and that is to assemble all of the information available on water treatment to remove or inactivate *Giardia* cysts into an engineering manual suitable for use by design engineers and water treatment plant operators. This project will be completed in 1991 and published in the following year.

STORAGE TANK *continued . . .*

control computer. On completion of the test a print out is given as a final report.

The system is not affected by temperature changes, tank dimensional changes, end deflection or trapped vapour pockets and has been found to have an accuracy down to 0.01 gal/hour leak detection.

This Alberta designed and manufactured detection system has now become the definitive method approved by the EPA of leak detection of storage tanks in the US. It is interesting to note, it was by the Vacutect Method, that service stations were tested for safety immediately following the recent earthquake in San Francisco.

Mr. Adams and his team are proud to be able to offer this piece of Alberta innovative technology not just to the US, but also world wide. He told *ALERT* that units are also now in operation in Spain and Portugal and other European countries have show interest. He said that had it not been for the wisdom, foresight, and confidence expressed in his organisation by the Alberta Environmental Research Trust through their several grants, this new system would probably have not been developed.

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